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FIFTH BI-MONTHLY PROGRESS REPORT
UNIVERSITY OF ALASKA
ERTS PROJECT 110-7
June 8, 1973

A. TITLE OF INVESTIGATION: Application of ERTS-1 imagery to the study of caribou movements and winter dispersal in relation to prevailing snowcover.

B. PRINCIPAL INVESTIGATOR/GSFC ID: Peter C. Lent/U682

C. PROBLEMS IMPEDING INVESTIGATION: Continued delay in arrival of color display unit.

D. PROGRESS REPORT:

1. Accomplishments during the reporting period: Aerial reconnaissance photography and observations on snow melt were obtained on May 21 for several selected sites within the winter range of the caribou population.

A detailed quantitative analysis of scene 1051-21002 was begun and has progressed as follows: A density printout of a selected portion of the scene was made from the NDPF digital tape. Preliminary analysis of the printout consisted of manual contouring of densities and identification of geographic reference points such as lakes, rivers, mountain peaks, summer *Aufeis* patches, etc. Next, selected features were outlined on the MSS band which appeared to define or delimit the feature most clearly. For example, band 7 was used to delimit lakes and shadows, band 5 was used to delineate *Aufeis*, spruce forest, muskeg, and treeless floodplain. After the features were delineated, MSS density printouts from the other three bands were registered to the reference band. The delineation outline was then transferred to all three of the other bands. The density printouts for all four bands were precisely registered, and the respective density figures for all four MSS bands at each point was keypunched onto an IBM card. Approximately 50 points or picels were obtained for each feature. Two types of shadow were used, namely, mountain shadow containing water bodies and mountain shadow not containing water bodies according to the USGS map for the area (Arctic, Alaska; 1:250,000; 1956, minor revisions 1966).

Initially, the card decks for a lake and a mountain shadow containing water bodies were used in connection with a biomedical computer program PBMD07M: Step-wise discriminate analysis. Each band density was treated as a variable, and the output indicated that band 6 densities were the best single variable for discrimination between shadows and lakes. The next best variable in this respect was indicated to be band 4 densities. Using all four variables, the program was able to categorize single lake points with 72% accuracy and single shadow points with 62% accuracy.

A sub-routine was then written to generate six "new" variables. These six variables consisted of ratios of image densities from various MSS band combinations for each picel under analysis as follows:

1. $\frac{\text{MSS 7}}{\text{MSS 4}}$ 2. $\frac{\text{MSS 6}}{\text{MSS 5}}$ 3. $\frac{\text{MSS 7}}{\text{MSS 5}}$

4. $\frac{(\text{MSS 7})^2}{(\text{MSS 4})(\text{MSS 5})}$ 5. $\frac{(\text{MSS 7})^3}{(\text{MSS 4})(\text{MSS 5})(\text{MSS 6})}$

6. $\frac{(\text{MSS 6})(\text{MSS 7})}{(\text{MSS 4})(\text{MSS 5})}$

The original four band densities plus the six ratios were entered as variables in the program analysis. Of these ten variables, the program output indicated that the three most useful or best variables for distinguishing between shadows and lakes were band 6 density, band 4 density, and the ratio of band 6 over band 5.

Using only band 6 and band 4 densities, the program correctly classified single lake points 84% of the time, but shadow points were correctly classified only 50% of the time. Using densities of band 6, band 4, and the ratio of band 6 over band 5, the program classified shadow points 64% correct and lake points 68% correct. Using all ten variables, the program correctly classified 68% of the shadow points and 76% of the lake points.

The shadow points classified as "lake" by the program were then plotted on the original density printout. These points were found to be clustered together in an oblong pattern in the northeastern portion of the shadow area. Close examination of USGS photos of the area indicated that there was a small stream in this area. A total of 17 points were involved and this corresponds to roughly 23 acres of surface area. This strongly suggests a capability for identification of water bodies even when these lie in dark shadows cast by adjacent mountains.

A second mountain shadow area in which no water bodies are mapped was selected, and the densities from this area were punched on cards. This new deck was used to characterize "shadow" in the program, and card decks for Aufeis, muskeg, spruce forest, and treeless floodplain were added. The sub-routine to generate the six ratio "variables" was not used, and therefore, the only variables entered in the program were the four MSS band densities associated with each point. Output from this analysis indicated the following: The best single variable for discrimination between the groups was band 5 density and this was closely followed by band 4 density. Band 6 density was also indicated to be quite useful in discrimination between the groups or categories. Band 7 densities were the least useful in this discrimination.

Initially, the program used only the band 5 density in discrimination and correctly categorized 80% of shadow points, 66% of lake points, 92% of Aufeis points, 76% of spruce forest points, and 76% of muskeg points, but it did not classify any of the "treeless floodplain" points in that category. Instead, 70% of these points were identified as "muskeg" by the analysis.

In a progressive step-wise fashion, the program incorporates variables in the discrimination until the last step where it uses all of the input variables. In this final output, correct categorization was only 56% for shadow, 46% for lake, 62% for muskeg, 56% for treeless floodplain, 56% for spruce forest, and 92% for Aufeis.

We conclude from this analysis that our initial categorizations were based on insufficient ground truth. The first step of the discriminate analysis provides reasonable indication of this because none of the points which we chose to call "treeless floodplain" were so classified, but 70% of these points were classified as muskeg. This strongly suggests to us that the two areas may be very similar in vegetational composition, and from the standpoint of plant communities, there may be very little difference between them. While we feel discriminate analysis of digital MSS band densities has great potential utility for analysis of ERTS imagery, we now require detailed ground truth of plant communities comprising caribou winter range, and are currently using a slightly modified version of Ohmann and Ream's (1971) technique to obtain this data.

Project personnel participated in an interagency coordination meeting for all biologists involved with the international "Porcupine" caribou herd. This meeting was organized by project cooperator Dr. Robert LeResche. Verbal agreements and arrangements were made for exchanges of data.

Work has started on mapping seasonal changes in snowcover from sequential analysis of ERTS images. A large portion of scene 1050-20541 has been classified as wet tundra, dry tundra, or snowcover based on visual analysis of a color composite transparency. These three features have been superimposed on Dr. R. LeResche's caribou trail system map for the same area. Further analyses of this type will be performed when the CDU and zoom transfer scope arrive.

2. Plans for next reporting period: Our field commitments during the next reporting period will permit little or no analysis of ERTS scenes. Through analysis of USGS aerial photos, we will select vegetation sampling sites within the winter range which are homogenous without apparent vegetational discontinuities, at least 50 acres in size, and representative of at least the four basic types of vegetation we expect to encounter: spruce forest, treeless bog, alpine tundra, and moist tundra. As soon as sites are selected, we will begin field activity collecting data for vegetative characterization using the basic technique described by Ohmann and Ream (1971).

   During periods of satellite overpass in late June and early July, aerial reconnaissance data will be obtained on locations of the post-calving aggregations of the "Arctic" herd in the DeLong Mountains and the "Porcupine" herd on the northeast Alaskan Arctic coastal plain.

E. SIGNIFICANT RESULTS: Step-wise discriminate analysis has demonstrated the feasibility of feature identification using linear discriminate functions of ERTS MSS band densities and their ratios. The analysis indicated that features such as small streams can be detected even when they are in dark mountain shadow. The potential utility of this and similar analytic techniques appear considerable, and the limits to which it can be applied to analysis of ERTS imagery are not yet fully known.

F. PUBLICATIONS: None during the reporting period.

G. RECOMMENDATIONS: None

H. CHANGES IN STANDING ORDER FORM: None

I. ERTS IMAGE DESCRIPTOR FORMS:

J. DATA REQUEST FORMS: None

K. LITERATURE CITED:

Ohmann, L.F. and R.R. Ream. 1971. Wilderness ecology: A method of sampling and summarizing data for plant community classification. U.S.D.A. Forest Service Research Paper NC-49. North Central Forest Experiment Station. St. Paul, Minn. 14 pp

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

NDPF USE ONLY
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ID

DATE May 31, 1973

PRINCIPAL INVESTIGATOR Peter C. Lent

GSFC U 682

ORGANIZATION Alaska Cooperative Wildlife Research Unit

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	Snow	Lake	River	
121120501 M		X	X	Major River Confluence
121120504 M			X	Mountains & Drainage
121719422 M	X		X	Mountains & Drainage
121819480 M	X		X	Mountains & Drainage
121819474 M			X	Mountain Drainage
121919535 M	X	X	X	Mountain drainage
122620322 M	X		X	Coastal Inlet
122620324 M	X		X	Mountain Drainage
122620331 M	X		X	Mountain Drainage
122620333 M	X		X	Mountain Drainage
122620340 M	X		X	Mountain Drainage
122720380 M	X		X	Mountain Drainage
122720385 M			X	Mountain Drainage
122720392 M	X		X	Mountain Drainage
122720394 M	X		X	Mountain Drainage
122820441 M	X		X	Mountain Drainage with Heavy Snowcover
122820435 M	X		X	Mountain Drainage
123121015 M	X		X	Mountain Drainage
123121012 M	X		X	Mountain Drainage
123121010 M	X		X	Mountain Drainage
123419364 M			X	Clouded Mountain Drainage
123619481 M	X		X	Clouded Mountain Drainage
123619474 M	X		X	Clouded Mountain Drainage
123719535 M	X	X	X	Major River Confluence
123719533 M	X		X	Mountain Drainage
123819594 M	X	X	X	Mountain Drainage
123819591 M	X	X	X	Mountain Drainage
123819585 M		X	X	Major River Drainage
123920041 M	X	X	X	Clouded Wet Drainage
123920043 M	X	X	X	Clear Wet Drainage
123920050 M	X		X	Mountain Drainage
123920052 M	X		X	Clouded Mountain Drainage

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

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	Snow	Lake	River	
124020110 M	X		X	Mountain Drainage
124020104 M	X	X	X	Mountain Drainage
124020101 M	X		X	Low Mountain Drainage
124020095 M	X	X	X	Low Mountain Drainage
124120153 M	X	X	X	Marshy River Drainage
124120160 M	X		X	Mountain Drainage
124120162 M	X		X	Mountain Drainage
124120165 M	X		X	Mountain Drainage
124720505 M	X	X	X	Mountain Drainage
124720502 M	X	X	X	Clouded River Drainage
124720493 M	X			Mountainous Coast
124720500 M	X		X	Mountain Drainage
125121130 M	X			Mountainous Snowcovered Coast
125219364 M	X			Mountain Drainage
125319422 M	X		X	Clouded Mountainous Area
125419481 M	X		X	Clouded Low Area
125419474 M	X	X	X	Mountain Drainage
125519535 M	X		X	Mountain Drainage
125519533 M	X		X	Mountainous River Confluence
125619591 M	X		X	Mountainous River Confluence
125619594 M	X	X	X	Mountainous Drainage
125619585 M	X	X	X	Major River Confluence
125720043 M		X	X	Major River Confluence
125720050 M	X		X	Mountain Drainage
125720052 M	X		X	Mountain Drainage
126020212 M	X			Heavily Clouded Mountainous Area
126020214 M	X		X	Mountain Drainage
126020221 M	X	X	X	Clouded Mountainous Area
126020223 M	X		X	Clouded Mountainous Drainage

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	Snow	Lake	River	
126120270 M	X		X	Mountainous Drainage
126120273 M				Heavy Cloud Cover
126120275 M			X	Heavy Cloud Cover
126120282 M	X	X	X	Mountain Drainage
126220322 M	X			Coastal Area
126220325 M	X	X	X	Mountain Drainage
126220331 M	X	X	X	Mountainous Drainage
126220334 M	X	X	X	Major Mountain Drainage
126220340 M	X	X	X	Mountainous Drainage
127219474 M	X		X	Cloud Cover
127219480 M	X		X	Clouded Mountainous Area
126420435 M	X			Coastal Area
126420441 M	X	X	X	Mountain Drainage
126420444 M	X	X	X	Major Mountain River Confluence
126420450 M	X	X	X	Mountain Drainage

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